

# NASA TECH BRIEF



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## Pulsed High-Voltage DC RF Sputtering

	Vapor Deposition	PREVIOUS METHODS			NEW METHOD RF Sputtering with Pulsed HV DC
		DC Sputtering	RF Sputtering	Ion Plating	
Line-of-sight Deposition Only	Yes	Yes	Yes	No	No
Plate Complex Shapes	Conditional <sup>1</sup>	Conditional <sup>1</sup>	Conditional <sup>1</sup>	Yes	Yes
Plate with Ele- mental Metals	Yes	Yes	Yes	Yes	Yes
Plate with Metal Alloy Systems	Some	Yes	Yes	Some	Yes
Plate with Semi- Conductors	Some	Yes	Yes	Some	Yes
Plate with Non- Conductors	Some	No	Yes	Some	Yes
Film Adhesion	Usually Poor	Good	Good	Excellent	Excellent

<sup>1</sup>Must rotate object

A new sputtering technique has been developed using pulsed high voltage direct current to the object to be plated and a radio frequency (RF) sputtered film source. This new technique combines the advantages of ion plating with the versatility of a radio frequency sputtered source. The advantages of this technique over other film deposition methods are shown in the Table.

Ion plating is an excellent method of plating because the resultant film has excellent adhesion, and because objects can be plated uniformly on all sides without rotating or moving them or the source of the film material. This method presently has one major disadvantage in that it employs a thermal evaporation source, and therefore film materials are limited to the elemental metals and those compounds which do not

dissociate before they evaporate. This limitation can be removed by using an RF sputtered source for the film material. An RF sputtered source represents the most universal source in general use today. Its use is not limited by the nature of the film material, and it can be used to sputter almost any material from insulators through semiconductors to metals.

In this new technique, an RF sputtered source is substituted for the thermal evaporation source normally used in ion plating. However, because the RF sputtered source supplies film material at a much slower rate than a thermal evaporation source, the ion plating process must be modified.

Ion plating is carried out in a low pressure ionized argon atmosphere with the object to be plated at a high negative potential. Consequently, the object to

(continued overleaf)

be plated is continuously bombarded (sputtered) by argon ions before, during and after the film material is injected into the ionized argon. If the evaporation rate of the film material is too slow, the film on the object to be plated will be sputtered away as fast as it develops and no film will result.

Since an RF sputtered source is inherently slow, under normal ion plating conditions no film would develop. Therefore, the ion plating process has been modified to reduce the rate of sputtering off of the newly formed film. This rate reduction was accomplished by pulsing the negative high voltage DC to the object to be plated. To establish a common electrode between the RF power source and the DC power source, a third electrode was inserted into the vacuum chamber between the sputtered source and the object to be plated. This electrode is in the form of a screen with a hole cut in the center to allow the sputtered material to reach the object to be plated.

At the start of the plating process, an argon atmosphere of from 10 to 20 microns pressure is established within the vacuum chamber. A high voltage DC negative potential (2-5 KV) with respect to the screen is continuously applied to the object to be plated which establishes a glow discharge within the vacuum chamber, thereby sputter-cleaning the object. After a predetermined period of sputter cleaning, the high voltage DC is shut off and the argon pressure lowered to about 10 microns. The RF power source to the film material is energized and sputtering of the film material begins, whereupon the high voltage DC is

switched to a timed on-off mode, re-energized and reapplied to the object to be plated. This pulsed high voltage DC negative potential on the object being plated is maintained throughout the plating period. The process is continued until the desired film is obtained.

The reduced sputtering rate of the film on the object to be plated results in the formation of a visible film having excellent adherence and covering the entire object.

**Notes:**

1. The main feature of this technique is that the plating of adherent alloy films on geometrically complex objects can now be accomplished simply, without any need for mechanical rotation relative to the sputtering source.
2. No additional documentation is available. Specific questions, however, may be directed to:

Technology Utilization Officer  
Lewis Research Center  
21000 Brookpark Road  
Cleveland, Ohio 44135  
Reference: B69-10699

**Patent status:**

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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